U.S. Army Center for Health Promotion and Preventive Medicine

USCHPPM

EPIDEMIOLOGIC CONSULTATION NO. 29-HE-8062-00
ACUTE RESPIRATORY DISEASE AND ADENOVIRUS INFECTION
AMONG U.S. ARMY BASIC TRAINEES AT
FORT JACKSON, SOUTH CAROLINA
1998

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Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

★ *Integrity is the foundation*
★ *Excellence is the standard*
★ *Customer satisfaction is the focus*
★ *Its people are the most valued resource*
★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

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13. ABSTRACT *(Maximum 200 words)*
An investigation of acute respiratory disease (ARD) and adenovirus infections was conducted among non-immunized basic trainees. This project involved three basic combat training (BCT) companies of the 1st Battalion, 28th Infantry Ft. Jackson, South Carolina. The epidemiological consultation consisted of three parts: 1) a recruit surveillance study, 2) an air filter study, and 3) a permanent party (cadre) study. The recruit surveillance study consisted of a total of 678 recruits which were followed through one 8-week cycle of BCT. Data was collected from a variety of sources, including interview, weekly symptom card, laboratory specimens, hospital admissions, medical records, training rosters and company master tracking system (MTS) databases. A total of 115 admissions (attack rate = 17%) were documented. Of these, 97 were evaluated clinically and serologically. In addition, 594 (88%) of 678 recruits were also evaluated at end of training. AdV infection was noted to occur among 83% of hospitalized cases and among 49% of non-hospitalized recruits. Detection of Ad4 DNA in air filters increased from week 0 to week 4 (18% to 75%; $p=0.004$) and declined to 1/12 (8%) on week 8 ($p<0.001$). A total of 39 (78%) male and 11 (22%) female cadre also participated in this study; 45 of them provided paired serum samples for anti-Ad4 testing. A total of 34 (75.5%) were immune or partially immune to Ad4, while 11 (24.5%) were non-immune to Ad4. Prior vaccination history was found to correlate with a higher level of immunity. This large epidemic of AD4-associated ARD in the 1st non-immunized recruit cohort studied after the loss of vaccine clearly establishes the impact that adenoviral infections have on military recruit training.

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U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
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REPLY TO
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EXECUTIVE SUMMARY
EPIDEMIOLOGIC CONSULTATION NO. 29-HE-8062-00
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1. INTRODUCTION. At the request of the Commander, U.S. Army Training Center at Ft Jackson, South Carolina, the U.S. Army Center for Health Promotion and Preventive Medicine (USAHPPM) conducted an investigation of acute respiratory disease (ARD) among basic trainees in the absence of adenovirus vaccine. This report details the results of an investigation to define the extent of ARD due to adenovirus, identify personal and environmental risk factors for infection, determine the proportion of recruits susceptible to infection with adenovirus, describe the clinical characteristics of adenovirus-associated ARD and recommend potential non-vaccine interventions to control future outbreaks.

2. STUDY DESCRIPTION.

a. This project involved three basic combat training (BCT) companies of the 1st Battalion, 28th Infantry at Fort Jackson, South Carolina. The epidemiological consultation consisted of three parts: 1) a recruit surveillance study, 2) an air filter study, and 3) a permanent party (cadre) study.

b. Outlined below is a summary of the 3 components in this project:

(1) Recruit surveillance study.

(a) A total of 678 recruits were followed through one 8-week cycle of BCT. Data were collected from a variety of sources, including interviews, weekly symptom cards, laboratory specimens, hospital admissions, medical records, training rosters and company master tracking system (MTS) databases. Of the 678 recruits who began training, there were 115 (17%) hospitalizations among 111 recruits. During the training cycle, ARD hospitalizations were twice as high in C (47 cases) and D companies (45 cases) compared to A company (23 cases). The peak in number of hospitalizations occurred during week 5 of BCT. The burden of illness appeared greater among female recruits and was greater among soldiers in C and D companies. Self-reported febrile illness peaked several weeks earlier in C company compared to A and D companies.

(b) A review of 634 (93.5%) medical records available at the end of training indicated 337 (53.2%) recruits had at least one documented visit to health care providers for an ARD-type illness. By comparison, a review of recruits' weekly, symptom cards with self-reported symptoms revealed a total of 626 (92.3%) out of 678 recruits sustained a respiratory illness and 354 (52.2%) reported a febrile ARD during training; respiratory disease attack rates were highest during the first four weeks of training.

(c) Fever/chills, sore throat, cough, nasal congestion and headache were the ARD symptoms reported in highest proportions by hospitalized recruits. Eighty-one percent (79 of 97) hospitalized ARD cases were found to be infected with adenoviruses (Ads) by throat culture; 70 (72%) of 97 were culture-positive for Ad serotype 4 (Ad4), 7 (7%) were infected with an serotype 3 (Ad3), and 2 (2%) were infected with serotype 21 (Ad21). Overall, 68 (82%) of 83 hospitalized recruit with paired serum samples had a $\geq$ 4-fold increase in neutralizing antibody titers to Ad4. Among the initially seronegative patients (i.e., non-immunes), 67 (92%) out of 73 had increased anti-Ad4 neutralizing antibody. By comparison, only 10 (12%) of 83 hospitalized recruits were found to be seropositive, (i.e., immune at titers of $\geq$ 1:32). Of these 10 immune patients, only 1 (10%) sustained an anti-Ad4 seroconversion.

(d) A nested, seroepidemiologic study involving 83 hospitalized patients and 166 gender-matched, non-hospitalized, unit contacts was conducted to examine risk factors for adenovirus type 4 (Ad4) infection and hospitalization. Overall, 69 (83%) of 83 hospitalized and 82 (49%) of 166 non-hospitalized recruits became infected with Ad4 during training. The entry anti-Ad4 immunity (titer $\geq$ 1:32) of these 2 groups was found to be 12% and 26%, respectively. Anti-Ad4 immunity was slightly lower for those recruits younger than 20 years and for those assigned to C and D companies. Risk factors for Ad4 infection included age less than 20 years (adjusted odds ratio [AOR], 3.58; 95% confidence interval [CI], 1.16-11.03) and male gender (AOR, 3.64; 95% CI, 1.76-7.52). Pre-existing high immunity (titer $\geq$ 1:32) was found to confer a high level of protection against Ad4 infection (AOR, 0.02; 95% CI, 0.005-0.06) and subsequent hospitalization (AOR, 0.40; 95% CI, 0.18-0.88). In addition, recruits who grew up in tropical regions of the world evidenced a significantly higher level of pre-existing immunity than those who grew up in temperate climates (OR, 2.79; 95% CI, 1.08-7.17).

(e) Self-perceptions of risk factors for ARD were consistent among companies with over 90% of the cohort reporting that they perceived an important relationship between acquiring an ARD and handwashing, and covering the mouth when coughing. A similar proportion perceived an important relationship between ARD's and poor air ventilation, while less than 70% perceived physical stress or fatigue as an important risk factor. It was also found that recruits from A company, which had the lowest attack rate, also reported the highest compliance with handwashing recommendations. Efforts to correlate handwashing practices and illness on an epidemiologic basis were not successful, however.

(2) Air Filter Study.

(a) Serial samples were obtained from ventilation system filters in recruit barracks' areas and tested for adenoviruses (AdV) by culture and polymerase chain reaction (PCR) as described elsewhere.[22] Of 59 air filters, 26 (44%) were Ad4-positive only by PCR. Sequence analysis confirmed the presence of Ad4. A total of 59 samples were collected at 2-week intervals from 25 September through 21 November 1998, at the end of training weeks 0, 2, 4, 6 and 8. An area of one square foot in the center of each filter was swabbed every two weeks with a swab pre-moistened in the cell culture media. In addition, swab specimens from 2 telephones in each of the 3 company areas (A, C and D) were obtained on 21 November (week 8).

(b) A 139-bp fragment indicating the presence of AdV was amplified from 26 of 59 non-extracted air filter samples (44 %) and 22 of 59 (37%) extracted ones. The results from extracted and non-extracted samples were concordant for 55 of 59 air filters (93%). None of the telephone specimens were positive for AdV by PCR. Attempts to recover AdV in cell cultures from air filters or phone surfaces were unsuccessful; all 65 samples were culture-negative.

(c) Based on the results from non-extracted samples, detection of AdV DNA in air filters increased from week 0 to week 4 (18% to 75%; $p=0.004$) and declined to 1/12 (8%) on week 8 ($p< 0.001$). The peak of ARD in October-November 1998 at Fort Jackson occurred during the weeks 4 & 5 of basic training. The proportion of AdV-positive air filters by PCR was also found to be greatest during this epidemic peak. The correlation coefficients for the 8-week period were 0.86 ($p=0.06$, Pearson's method) and 0.90 ($p=0.04$, Spearman's rho method).

(d) To identify the amplified fragments, the nucleotide sequence of amplified fragments were analyzed from three samples selected randomly and confirmed to be PCR-positive with and without extraction. The sequences had highly significant homology with Ad4; the probability values (E values) for a random match were 4×10^{-29}, 8×10^{-30} and 9×10^{-36}.

(3) Permanent Party (Cadre) Study.

(a) A total of 50 of approximately 60 cadre provided data and laboratory samples at the beginning of the study. A total of 39 (78%) male and 11 (22%) females participated (mean age of 32.0; range=21-44). A majority of the cadre were drill sergeants (64%), while 24% were administrative and 12% were officers. During the cycle, 19 (38%) of cadre reported having a respiratory illness, while 8 (16%) reported sustaining a febrile ARD. Rates of respiratory illness in cadre of C company (56%) were higher than for cadre assigned to A (29%) or D (40%) companies, though not statistically significant. Collectively, the cadre experienced 123 sick days and missed 21 work days due to respiratory illness. Of 44 medical records available for review, 16 (36%) had at least one documented visit to a health care provider for an ARD-like illness in

1997-98; there were no hospitalizations recorded among this group. AdV vaccination history from medical records revealed that 19 (43%) received the vaccine and 25 (57%) did not. Prior vaccination history was not associated with a decrease in respiratory disease rate.

(b) Forty-five pairs of blood samples (pre- and post-training) were available for serological analysis. A total of 34 (75.5%) were immune or partially immune to Ad4, while 11 (24.5%) were non-immune to Ad4. All three cadre who seroconverted were initially non-immune (titer < 1:4) and 2 of the 3 had not received AdV vaccine in the past (1 with unknown data). All 3 seroconverters also reported having had a respiratory illness during the cycle (one febrile ARD, 2 afebrile ARD). Prior vaccination history was found to correlate with a higher level of immunity; 11 (85%) of 13 vaccinated cadre were immune at baseline compared to 11 (61%) of 18 unvaccinated personnel (P=0.01, Fisher's exact test). In addition, lack of immunity (titer < 1:4) was also found to correlate with Ad4 infection; 3 (27%) of 11 non-immune cadre seroconverted to anti-Ad4 compared to none of 34 immune cadre (P=0.01, Fisher's exact test).

3. DISCUSSION.

a. Recruit Surveillance Study. The results of this investigation clearly illustrate the high level of susceptibility to Ad4 infection of incoming recruits as well as its high-degree of communicability during training. Over 90% of recruits in this investigation experienced respiratory symptoms at some time during the training cycle, while over half of the cohort reported a febrile respiratory illness. More than half of this cohort had a documented visit to a health-care provider for an ARD-type illness and about 17% was hospitalized for an ARD. Based on these data, only about 1 of every 4-5 cases of ARD subsequently underwent hospitalization. Peak rate of hospitalizations occurred during weeks 4 & 5 of training, while self-reported febrile illnesses peaked during week 3. An ARD hospitalization was not related to leaving the cohort for any reason, and no soldiers were discharged or recycled exclusively due to an acute respiratory disease.

b. Air Filter Study. Laboratory analysis confirmed the presence of Ad4 in the barracks' ventilation system. The number of Ad4-related hospitalizations was directly correlated to the proportion of filters containing Ad4 by polymerase chain reaction (PCR). The PCR may serve as a useful technique to enable us in the future to detect and quantify AdV-ARD exposure and may also enable further definition of the potential environmental effects the transmission of AdV in this setting.

c. Permanent Party Study. The impact of adenoviruses among non-recruit populations should not be overlooked. The results of this small investigation suggest that permanent party personnel who have not been immunized previously with AdV vaccine are also at risk for adenovirus infections given a lower level of immunity.

4. RECOMMENDATIONS.

a. The optimal measure for preventing outbreaks due to AdV is immunization, as demonstrated by the successful control attained after initiation of an adenovirus immunization program in the early 1970's. In the absence of vaccine, military recruits are vulnerable to these infections, just as they were during earlier decades (1940's-1960's). Until vaccines are once again available, there is a need for other approaches to inhibit the spread and minimize the costs of AdV infections among trainees. In addition to recruits, it may also be prudent to consider immunization of permanent party (cadre) personnel upon arrival on-post in order to decrease their susceptibility to infection with adenoviruses.

b. Emphasis should be given to the implementation of non-vaccine acute respiratory disease interventions (NOVARDI) such as increased emphasis on hand-cleaning, provision of adequate personal space, head-to-toe bunk orientation, improved ventilation systems and air exchanges in sleeping barracks and timely exchange of HVAC air filters within these systems.

c. Employ AdV countermeasures and preparation for outbreak situations that include, emphasis on hygiene and reduction of crowding when possible. In extreme ARD outbreaks, acquision of additional barracks space, supplemental staff or delay in the entry of new, non-immune recruits may be necessary.

d. Weekly surveillance for ARD should be considered the most critical step in addressing the resurgence of this adenovirus challenge. Appropriate adenovirus surveillance should include tracking of general ARD, as well as sampling for specific pathogens among hospitalized ARD cases. Such a system is already in effect at Fort Jackson and other Army and Navy basic training posts.

CONTENTS

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ACUTE RESPIRATORY DISEASE AND ADENOVIRUS INFECTION AMONG U.S. ARMY BASIC TRAINEES AT FT JACKSON, SOUTH CAROLINA 1998

1. INTRODUCTION. This epidemiologic consultation was initiated in response to a letter dated 2 September 1998 from MG VanAlstyne (Commander, U.S. Army Training Center at Ft Jackson, South Carolina) to BG Patrick Sculley [Commander, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)] requesting assistance in investigating the increase of acute respiratory disease (ARD) among basic trainees in the absence of adenovirus vaccine. COL Jose L. Sanchez (Chief, Epidemiology Services Program, USACHPPM) and COL William A. Bester [Commander, Moncrief Army Community Hospital (MACH), Fort Jackson] outlined initial short- and long-term goals for this investigation, to include a prospective (cohort) study. This report outlines the results of this investigation. The tasking letter is attached as Appendix B.

2. HISTORICAL BACKGROUND.

a. Before the initiation of widespread immunization against adenovirus in 1971, acute respiratory disease (ARD) was the most common cause of morbidity and hospitalization among recruits in basic combat training (Appendix A, reference 1). During the 1960's ARD due to adenoviruses occurred in 50-80% of basic trainees, resulting in losses of manpower, hospital overflow, and compromise of training activitie (Appendix A, reference 1). The disruption of military training due to ARD thus led the Commission on Acute Respiratory Diseases of the Armed Forces to recognize adenovirus as the main cause of acute respiratory disease epidemics among military recruits.

b. The implementation of a routine immunization policy in 1980 for vaccination against adenovirus types 4 (Ad4) and 7 (Ad7) resulted in dramatic decreases in ARD infections (Appendix A, reference 2). All male Army recruits received Ad4 and Ad7 immunizations regardless of entry date. Female recruits were not routinely vaccinated due to reproductive health concerns (see package insert, Wyeth-Ayerst Laboratories, Philadelphia, PA). Routine immunization continued until the mid-1990's. Thereafter, the sole vaccine manufacturer, Wyeth-Ayerst Laboratories, informed the DoD that their facility would close due to compliance concerns with the Food and Drug Administration (FDA), Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA). Efforts to re-establish vaccine manufacture were unsuccessful. In 1996, the last supplies of vaccine were delivered and the Army ceased year-round vaccination. Seasonal immunization was implemented in order to

ration supplies while targeting ARD during the high-risk period of October through March. In 1997, the FDA allowed an extension of the vaccine expiration dates in order to utilize current stocks, but enteric coating deterioration of the Ad4 vaccine allowed only for the extension of Ad7 vaccine. At present, there is no vaccine manufacturer and the Defense Support Center, Philadelphia (DSCP) stocks of supplies were already depleted in the spring, 1999. This cessation of AdV vaccination initially led to speculations that ARD illnesses, hospitalization rates, and training disruptions would rise to pre-vaccine era levels.

c. At Fort Jackson, South Carolina, the US Army's largest basic combat training (BCT) installation, routine immunization ceased during one cycle in the spring of 1996 and for approximately 8 months during the spring-fall of 1997. Each of these lapses in immunization was followed by increasing ARD and AdV rates in the same year (Figure 1, Appendix G) (Appendix A, references 3-7). Although post-wide ARD rates did not exceed the outbreak threshold of 1.5% per week, during 1997, 32 individual training companies did exceed this threshold. Seven of these 32 experienced ARD attack rates as high as 5-10% per week. This outbreak was investigated by a USACHPPM EPICON team and is summarized elsewhere (Appendix A, reference 3). Delays in obtaining new lots of vaccine led to this outbreak. Illness rates dropped immediately after immunization of new recruits resumed from November 97 through April 98. By the following 1998 ARD season, AdV vaccine supplies at Fort Jackson had been completely depleted. A limited supply of Ad7 vaccine was available, however, historically, ARD outbreaks at Fort Jackson have been due primarily to Ad4. Nevertheless, immunization of recruits with Ad7 vaccine resumed in December 1998 through March 1999.

d. The Naval Health Research Center (NHRC) performs active surveillance of respiratory disease and AdV infections among recruits at several Army and Navy basic training sites, including Fort Jackson ('Figure 2, Appendix G). Of 2,926 specimens collected from recruits between June 1998 and December 1999, 57% were AdV positive, including several from recruits who received the Ad7 vaccine. However, over 94% of these AdV isolates came from recruits who did not receive any AdV vaccine (Appendix A, reference 4).

3. PURPOSES AND OBJECTIVES. The objectives of this Epidemiologic Consultation (EPICON) included the following:

a. To define the extent of acute respiratory disease due to AdVs.

b. To identify personal and environmental risk factors for infection with AdVs.

c. To determine the proportion of recruits susceptible to infection with Ad4.

d. To describe the clinical characteristics of acute respiratory disease due to Ad4.

e. To recommend potential non-vaccine interventions to control AdV-associated respiratory disease.

4. STUDY DESIGN. This epidemiologic consultation consisted of three parts: 1) a recruit surveillance study, 2) an air filter study, and 3) a permanent party (cadre) study.

a. Recruit Surveillance Study. The study cohort was comprised of all trainees in companies A, C, and D, 1st Battalion, 28th Infantry Regiment (1-28th Infantry Battalion) participating in the basic training cycle occurring between 1 October 1998 and 23 November 1998 (7 weeks and a partial 8th week due to Thanksgiving holiday). The 1-28th was housed in a "starship" type building (Figure 3, Appendix G). Excluded from the cohort were trainees assigned to B company, a newly created company where motivational training was provided for recruits from other BCT units at Fort Jackson.

(1) Methods.

(a) Data Sources. For this project, data were collected from a variety of sources, including interviews, weekly symptoms cards, laboratory specimens, hospital admissions, medical records, training rosters and each company's master tracking system (MTS) databases.

(i) Demographic information. Demographic data were obtained for both the trainee cohort and cadre cohort upon arrival to Fort Jackson and at the end of the training cycle through written questionnaires (Appendix C). Data included name, date of birth, gender, race/ethnicity, place of birth, smoking status, and acute respiratory disease (ARD) symptomatology. Additional demographic information for trainees was obtained from each company's master tracking system, a company-based database with demographic and training information for each recruit.

(ii) Laboratory specimens.

a) Serum samples. To determine an entry and exit level of immunity, 15 milliters (ml) of venous blood were drawn from each recruit and cadre at the beginning and end of the cycle. A sample of acute and convalescent (2-4 weeks after illness) sera were also collected from ill recruits admitted to the infirmary meeting the case definition of a febrile ARD during the 8-week cycle. Blood samples were centrifuged and sera were aliquoted and immediately frozen at -70^0C on-site. All acute patients' sera as well as a sub-cohort of 83 hospitalized cases and 166 gender and unit-matched non-hospitalized controls with paired (entry and exit) serum samples were tested for anti-Ad4 neutralizing antibody titer determination (Appendix A, reference 5).

b) Nasopharyngeal swabs. Nasopharyngeal swabs were obtained from recruits exhibiting ARD symptoms during the initial blood collection. For each swab taken from the throat of an ill recruit, another swab was obtained from the next recruit who exhibited no ARD symptoms. A nasopharyngeal swab was also obtained from the throats of ill recruits admitted to the infirmary

meeting the case definition of a febrile ARD during the 8-week cycle. Dacron-tipped swabs were used to scrape the posterior oropharynx of ill recruits and immediately placed in refrigerated cell culture media and vortexed in accordance with already-published guidelines (Appendix A, reference 23).

(iii) Weekly diary cards. At the end of each training week, recruits recorded ARD symptomatology on pre-printed diary cards. These diary cards were administered weekly during a morning formation (Appendix D).

(iv) Barracks assignments. For each recruit, barracks location, bunk location, head orientation, and proximity to air ventilation ducts was recorded. This information was correlated with weekly ARD symptoms.

(v) Hospitalizations. Febrile patients admitted to the infirmary for ARD were interviewed upon admission using standardized respiratory disease questionnaires (see Appendix E). Data were collected on week of training, main complaint, previous medications, onset and duration of illness, prior visits to sick call, missed training and ARD symptomatology.

(vi) Medical Records. When a soldier enters the medical system, forms are generated and placed in the recruit's medical record. These records are stored at the Troop Medical Clinic (TMC). Each recruit's medical record was reviewed at the end of the 8-week training cycle or at the transition point (if separating). For each trainee and cadre in the 1-28th Infantry Battalion, we extracted the following data for each visit to a medical care provider: date of visit, duration of symptoms (self-reported), diagnosis, and days of limited duty. This information was generally available on one of three forms: Department of the Army Form 5181-R (Screening Note of Acute Medical Care), Standard Form 600 (Chronology of Medical Care), or Standard Form 558 (Emergency Care and Treatment Form).

(vii) Alpha Rosters, Newstarts and Discharges. Alphabetical listings of trainees (A rosters) were maintained by USACHPPM for each company. These rosters were updated daily to reflect gains and losses to the battalion and provided denominator data for calculating rates. Newstart data were provided by the battalion S-3 (Plans, Training, and Operations Section). Newstart-ins were trainees entering the battalion because they did not complete mandatory training requirements in another battalion. These recruits could enter and leave the unit at any point during the cycle, depending on the recruit's training needs. These recruits were not part of the adenovirus study cohort, however, their presence was recorded to minimize confusion. Newstart-outs were trainees leaving the 1-28th Infantry Battalion because they could not complete required training. Once a recruit left the 1-28th for any reason, he was no longer considered to be part of the study cohort.

(b) Case Definitions.

(i) A case patient with febrile ARD was defined as a recruit assigned to the 1-28th Infantry Battalion presenting to the infirmary during the 8-week training cycle with an oral temperature of 100.5°F or greater and one or more of the following signs/symptoms: sore throat, cough, nasal congestion, rhinorrhea, hoarseness, sinus tenderness, or rales/rhonchi/wheezing.

(ii) A case patient with non-febrile ARD was defined as a recruit assigned to the 1-28th Infantry Battalion with an oral temperature < 100.5°F and one or more of the above symptoms during the training cycle.

(iii) Data Analysis. After editing for out-of-range and invalid entries, frequency cross-tabulations were evaluated for obvious correlations or risks. A variable was created to adjust for population variances over time and data were standardized to recruit-weeks of training. Odds ratios (OR) and 95% confidence intervals (95% CI) were calculated and hypotheses were tested using the Pearson's Chi-square for differences in disease experience and risk. For the nested case-control study, univariate analysis was performed and odds ratios (OR) on odds of Ad4 infection or hospitalization (and 95% CI) estimated. Gender-stratified analysis (univariate) of study variables was performed. Proportions were compared by the chi-square or Fisher's exact tests (two-tailed). Risk factors found to be important in univariate analysis or believed to be potential confounders were included in an unconditional multivariate logistic regression model with Ad4 infection and hospitalization as separate outcomes and expressed as adjusted odds ratios (AOR).

(2) Results.

(a) Data Collection Limitations. Because of the dynamic nature of this cohort complete data were not available for every recruit. Self-reporting biases may also present a limitation. Baseline sera collection was interrupted, resulting in 422 recruits providing sera at reception and 256 providing sera during the first week of training.

(b) Demographic Data (Tables 1 and 2, Appendix F).

(i) Population. A total of 678 recruits constituted our study cohort and they were evenly distributed across companies. By the end of the cycle, a total of 84 recruits had left the cohort (Figure 4, Appendix F). Of these 84, 54 (64.3%) were discharged for various reasons, 24 (28.6%) were injured and transferred to PTRP (Physical Therapy Rehabilitation Platoon) and 6 (7.1%) went to a motivational company.

(ii) Gender. There were 405 (59.7%) male and 273 (40.3%) female recruits in the cohort. The male to female ratio in A and C companies was approximately 1:1, while in D company, males outnumbered females 3 to 1. Among males, 116 (28.6%) were assigned to A company, 119 (29.4%) to C company, and 170 (42%) to D company. Among females, 111 (40.7%) were assigned to A company, 106 (38.8%) to C company, and 56 (20.5%) to D company.

(iii) Age. The mean (median) age of this cohort and each company was 20.0 (19) for both men and women and ranged between 17-37 years.

(iv) Race/Ethnicity. The cohort was characterized by the following race/ethnic strata, 46.5% White, 32.9% Black, 12.2% Hispanic, 2.5% Asian and 5.9% Other.

(v) Smoking Status. Approximately 60% of the study cohort was made up of non-smokers. An additional 30% were current smokers and the remaining 10% were classified as ex-smokers. There was no difference in the distribution of smoking practices by unit of assignment.

(vi) Domicile. Most of this cohort (91%) lived most of their lives in the United States, while 9% lived overseas. An equal distribution among companies was observed for each region/strata.

(c) Morbidity data.

(i) ARD symptoms.

a) Start of Cycle. At the Reception battalion, (17-22 September 1998) baseline sera and questionnaire data were obtained from 422 (62.2%) of 678 recruits in the cohort. The remaining 256 (37.8%) were interviewed and provided sera during the first week of training (10 October 1998). There was no difference in the demographic characteristics of the group who were interviewed at the Reception Bn and those interviewed after week 1 of training. The following Reception Bn data results are based on a cohort of 422. Unless otherwise indicated, all other analysis includes the entire cohort of 678.

b) Reception. At reception, 29.1% (123 of 422) indicated that they had one or more ARD symptom, while only 5.0% (21 of 422, 95% CI=2.9-7.1) indicated that they had ARD symptoms accompanied by fever (febrile ARD). By the end of week 1 of training (after recruits had moved to the 1-28th training Bn), a significantly higher proportion (14.0%, 95% CI=10.6-17.5) of these recruits reported a febrile ARD. This represents a 180% increase in febrile ARD reporting. By the end of the 8-week cycle, 354 (52.2%) of this group had reported having a febrile ARD at any time during training, a change of 942%.

c) Training Cycle. During the basic training cycle, a total of 626 (92.3%) of the initial 678 recruits in the cohort reported having symptoms of respiratory illness sometime during BCT. Reports of illness were highest among recruits in C company (96.4%) followed by D company (92.9%) and A company (87.7%). By gender, 90.4% of all males and 95.2% of all females reported ARD symptoms during the 8-week basic training cycle. C company (95.0%) displayed the greatest proportion of males reporting ARD symptoms, followed by D company (92.4%) and A company (82.8%). The proportion of females reporting ARD symptoms was similarly distributed and highest in C company (98.1%) followed by D company (94.6%) and A company (92.8%).

(ii) Self-Reported Febrile ARD. During the training cycle, 354 (52.2%) of the cohort reported having a febrile ARD. The attack rates for self-reported febrile ARD were 48.9%, 53.3% and 54.4% among companies A, C and D respectively (Table 3 and Figure 5, Appendix F). Although A company reported lower proportions of febrile illness than C or D companies, these differences were not statistically significant. No significant differences were observed between males and females overall, or by company.

(iii) Sick call visits (self-reported). During week 1, C company reported a significantly higher proportion (36.0%, 95%CI=29.4-42.6) of sick call visits compared to D company (20.4%, 95%CI=14.9-25.9) or A company (6.5%, 95% CI=3.1-10.0). C company also reported significantly higher sick call visits in week 2 (41.2%, 95% CI=34.2-41.4) compared to D (17.4%, 95%CI=12.2-22.6) or A company (25.1%, 95% CI=19.1-31.2). There were no significant differences in reports of sick call visits for the remaining weeks of training, except for week 7, when A company reported a significantly higher proportion of visits (7.9%, 95%CI=4.2-11.5) compared to D company (1.1%, 95%CI=-0.4-2.5), but not C company (4.7%, 95%CI=1.7-7.7).

(iv) Medical provider visits (by record review). A total of 634 (94%) recruit medical records were reviewed at discharge, PTRP or end of training. Of these, 337 (53.2%) recruits in our cohort had at least one documented medical visit for an acute respiratory illness. A company had a significantly lower proportion (39.4%, 95%CI=32.8-45.9) of recruits with a documented ARD compared to C (62.9%, 95%CI=56.3-69.4) or D (57.7%, 95%CI=51.0-64.4) companies.

(v) Hospitalizations. A total of 115 (representing 111 recruits) hospitalizations (2.4 per 100 recruit-weeks of training) for acute respiratory illness occurred during the study period. The proportion of hospitalizations was highest among C company, with an ARD hospitalization rate of 20.9% followed by D company (19.9%) and A company (10.1%) (Table 4 and Figure 6, Appendix F). A total of 6,138 hours, or 255.8 days were lost due to hospitalizations for respiratory illnesses. Hospital stays ranged from 0.5 to 12 days, and the mean (median) number of hospital days was 2.2 (2). The length of hospitalization did not differ significantly by gender or company. Of hospitalizations, 85 were febrile ARD's with oral temperatures ranging from 100.5-105.0° F, and a mean temp of 102.0°F (median=101.8 °F). The distribution of symptoms among the hospitalized recruits is illustrated in Table 5. C and D companies' risk of hospitalization was approximately 2-fold (RR = 2.01, 95% CI = 1.31-3.09) greater than that of A

company. For C company, the risk of having an ARD hospitalization was 2.06 (95% CI=1.30-3.20) times that of A company. For D company, the risk of having an ARD hospitalization was 1.97 (95% CI=1.23-3.14) times that of A company. There was no observed difference in the risk of having an ARD hospitalization between C and D companies.

(vi) Discharges and Recycles due to ARD. No soldiers were discharged or recycled due to an acute respiratory disease. An ARD hospitalization was not related to leaving the cohort for any reason, and there was no significant difference in hospitalization rates between those who left the cohort and those who remained until graduation.

(d) Laboratory analysis.

(i) Nasopharyngeal swabs. A total of 97 throat swabs were obtained from hospitalized recruits and 79 (81%) yielded AdV types 4, 3, or 21. Ad 4 accounted for 70 of the 79 AdV-positive types. Ad3 accounted for 7 and Ad21 for 2 of the remaining 9 AdV isolates detected. Additionally, 4 polioviruses, 1 unknown picorna-like agent and a herpes virus were recovered. The number of AdV isolates was noted to increase steadily, reaching a peak in week 5 of training (Figures 7 and 8, Appendix F).

(ii) Serum samples. Overall, 69 (83%) of 83 hospitalized recruit with paired serum samples had a $\geq$ 4-fold increase in neutralizing antibody titers to Ad4 (Table 6, Appendix F). Among the initially seronegative patients (i.e., non-immunes), 68 (93%) out of 73 had increased anti-Ad4 neutralizing antibody. By comparison, only 10 (12%) of 83 hospitalized recruits were found to be seropositive, (i.e., immune at titers of $\geq$ 1:32). Of these 10 immune patients, only 1 (10%) sustained an anti-Ad4 seroconversion. Additional serum neutralization tests to adenovirus types 3, 7a and 21 were carried out on paired serum specimens from selected patients (Table 7, Appendix F). The patients tested were those who had an adenovirus 3 or 21 isolates as well as patients without an isolate. There was a 4-fold or greater increase in antibody titer in each patient from whom a similar isolate was obtained. Many of the patients infected with adenovirus type 3 responded to adenovirus 7a and 4. The reactions to type 7a represent a heterotypic rise to an antigenically-related virus, and the rise to type 4 is probably due to a dual infection with types 3 and 4. Two Ad4 seroconversions were observed in patients from whom no virus was isolated.

(e) ARD risk factors.

(i) Smoking. Smoking was not related to reporting a febrile ARD or an ARD hospitalization. Leaving the cohort was, however, related to smoking. Smokers (including former smokers) had 6.9 times ($p<0.009$) the odds of leaving the cohort when compared to non-smokers.

(ii) Perception of various risk factors. This cohort showed no differences by company in their perception of risk factors or behaviors related to acquiring an ARD.

(iii) Handwashing practices. A company reported 4 or more handwashes per day, including showers, (70.4%) in higher proportions than C company (56.6%) or D company (42.9%). This finding, however, was not statistically significant at the .05 confidence level (Table 8). There was no correlation between handwashing frequency and illness rates.

(f) Case-Control Data Analysis.

(i) Description of population (Table , Appendix F). A total of 83 (75%) of the 115 hospitalized and 166 (34%) of the 483 non-hospitalized recruits who had paired (entry and exit) serum samples were tested for anti-Ad4 neutralizing antibody titer. The 2 groups were similar with respect to age, gender, unit and racial distribution. Approximately one-third were previous smokers and almost one-half reported smoking by other household members. Only a minor fraction (10-17%) of both groups were born or raised in a tropical region of the world.

(ii) Immunity of recruits. Overall, 69 (83.1%) of 83 hospitalized and 82 (49.4%) of 166 non-hospitalized recruits with paired serum samples were found to seroconvert to Ad4 (i.e., became infected with Ad4) during training (Table 10, Appendix F). The entry anti-Ad4 immunity (titer $\geq$ 1:32) of these 2 groups was found to be 12.0% and 25.9%, respectively. Anti-Ad4 immunity was slightly lower for those recruits younger than 20 years and for those assigned to C and D companies (Table 11, Appendix F). Recruits who grew up in tropical regions of the world evidenced a significantly higher level of pre-existing immunity than those who grew up in temperate climates (OR, 2.79; 95% CI, 1.08-7.17).

(iii) Recruit's rates of infection. Recruits with an anti-Ad4 entry titer of at least 1:32 were found to sustain a much lower rate of Ad4 infection than those with non-detectable (less than 1:2) titers (OR, 0.08; 95% CI, 0.02-0.30). A clear inverse (i.e. protective) relationship was noted for pre-existing anti-Ad4 immunity and subsequent infection (i.e. seroconversion) with Ad4 (Figure 9, Appendix F). Hospitalization rates were also inversely related to the pre-existing level of anti-Ad4 immunity. Of the 144 recruits with low or non-detectable serum neutralizing antibody titers (1:4 or less), 64 (44%) were hospitalized. By comparison, only 9 (17%) of 52 recruits with initial titers of 1:8-1:16 and 10 (19%) of 53 recruits with initial titers of 1:32 or greater, respectively, were hospitalized.

(iv) Risk factors for Ad4 infection. To determine which risk factors were associated with Ad4 infection, univariate and multivariate analysis was performed (Table 12, Appendix F). The risk of infection was significantly higher for recruits younger than 20 years of age (AOR, 3.58; 95% CI, 1.16-11.03), and for male recruits (AOR, 3.64; 95% CI, 1.76-7.52). The most important factor in determining Ad4 infection during training, however, was the pre-existing anti-Ad4 immunity. Recruits with high baseline immunity (titer of at least 1:32) were found to only have 2% the risk of infection of those with lower titers (OR, 0.02; 95% CI, 0.005-0.06).

(v) Risk factors for hospitalization. The risk of hospitalization due to a febrile ARD was also evaluated (Table 13, Appendix F). Again, pre-existing immunity to Ad4 was found to be highly protective for hospitalization (AOR, 0.40; 95% CI, 0.18-0.88). In addition, individuals who experienced an initial episode of a febrile ARD upon arrival at Fort Jackson were at increased risk of hospitalization later on during BCT (AOR, 4.85; 95% CI, 1.66-14.16). No significant associations were found for age, gender, unit assignment, race, prior smoking history or birth region.

(3) Discussion.

(a) Following the loss of live oral adenovirus types 4 & 7 vaccines, epidemics of febrile ARD due to adenovirus types 4 & 7 have re-emerged during basic training in U.S. military recruits. This study among recruits at Fort Jackson documents the ubiquitous nature of AdV-associated acute respiratory illnesses among military trainees. In the absence of vaccine-induced immunologic protection, AdVs have re-emerged as the predominant pathogenic respiratory agents among military trainees in the U.S. (Appendix A, references 6 and 7). Approximately one-half of recruits undergoing 8-week BCT developed significant febrile illnesses; approximately one in every five of these ill recruits was hospitalized.

(b) The high attack rates (17% ARD hospitalization rate) are comparable to the attack rates seen among recruits during the pre-vaccine era (Appendix A, reference 8). Previous studies conducted 40-50 years ago among field artillery recruits at Fort Bragg, North Carolina, in 1942-45 (Appendix A, reference 8); among Marine Corps recruits at Parris Island, South Carolina (Appendix A, reference 9) and at Camp Lejeune, North Carolina in 1964 (Appendix A, reference 10); among recruits at the Naval Training Center (NTC), Great Lakes, Illinois, in 1954-56 (Appendix A, references 11 an 12); and, among recruits at the NTC and Marine Corps Recruit Depot (MCRD), San Diego, California, in 1953-63 (Appendix A, references 13 and 14); documented the role that Ads had in producing large, winter-time outbreaks of ARD. Our experience with non-immunized Army recruits almost one-half century later clearly illustrates the re-emergence of AdV-associated respiratory disease.

(c) The high-level of susceptibility in young adults less than 20 years of age in this study most likely reflects a lack of exposure in childhood (Appendix A, references 15 and 16) Previous seroepidemiologic studies conducted 35 to 40 years ago in the United States and England seemed to indicate that AdV types 4 and 7 infected children less often than other types (Appendix A, references 17 and 18). More recently, in a seroepidemiologic study of Army recruits conducted in 1992 by Ludwig et al (Appendix A, reference 19), it was estimated that only approximately 30% of incoming recruits were immune to Adv types 4 or 7. The low level of pre-existing immunity documented among recruits during our investigation (12% of hospitalized and 26% of non-hospitalized controls) further highlights the increasing risk for AdV-associated respiratory illnesses among young adults in the U.S.

(d) Our finding that recruits from tropical regions of the world had a higher level of pre-existing immunity to Ad4 was unexpected. No such relationship has been noted previously. The protective effect of high, pre-existing serum neutralizing anti-Ad4 immunity, has been well documented in this study and mimics similar findings of studies of AdV-affected military recruits prior to vaccine availability (Appendix A, references 9, 10 and 20).

(e) Virus isolation tests on recently arriving recruits with ARD symptoms did not detect any adenoviruses in their throat specimens. This finding suggests that these viruses were not being introduced by these recruits. Results of the virus isolation and antibody tests clearly indicate that Ad4 was highly associated with febrile ARD in both male and female basic trainees. Antibody studies of the "contact" recruits also indicated that Ad4 was circulating widely on-post. Over 80% of the recruits with febrile ARD who arrived without anti-Ad4 neutralizing antibody developed a rise in neutralizing antibody as did nearly one-half of the "contact" recruits. The recovery of adenovirus types 3 and 21 occurred in comparatively small numbers and the antibody tests confirmed the isolations, but did not detect additional infections. The overall findings markedly agree with the observations made 30 years ago and clearly highlight the necessity for reinstitution of an AdV vaccination program.

b. Air Filter Study. Air filters samples were collected from recruit sleeping barracks (Starship-type building). The system is designed to recirculate over 90% of the air back into the barracks. Recruit sleeping areas were located in wings (east and west) on the 2nd and 3rd floors of the building. A company, which had an older ventilation system of four units, one for each floor (2nd and 3rd) and wing (east and west). C and D companies had newer ventilation systems located only on the 2nd floor, one unit on each wing, to supply air to both floors. In A and D companies, filters were changed 3 times: prior to week 0, between weeks 2 and 4 and between weeks 6 and 8. In C company filters were changed twice: during weeks 2 and 4 and during weeks 6-8.

(1) Methods.

(a) Sample collection. A total of 59 samples were collected at 2 week intervals from 25 September through 21 November 1998, which corresponded to the end of training weeks 0, 2, 4, 6 and 8. Serial environmental specimens were obtained by swabbing the surfaces of high-efficiency filters from eight air handling systems (ventilators) in the barracks. Filters from all the ventilation units were swabbed on the side where the air entered into the circulation unit (dirty side). An area of one square foot in the center of each filter was swabbed every two weeks with a swab premoistened in the cell culture media. Specifically, in A company one sample was obtained from each filter (total n=4) at each time. In companies C and D, samples from the top and bottom filters of each ventilation unit were sampled (total n=4 per company) at each time. Samples were inoculated into 5ml of cell culture media with antibiotics, and frozen at –70° C until tested. In addition, swab specimens from 2 telephones in each of the 3 company areas (A, C and D) were obtained on 21 November (week 8).

(b) Culture. The collected frozen samples were thawed, vortexed, centrifuged, inoculated in A549 cells in tube cultures, and the remaining aliquot was refrozen until tested by polymerase chain reaction (PCR) (Appendix A, reference 21). The cultures were incubated for 21 days at 35° C and observed twice-a-week for AdV cytopathic effects. The susceptibility of the cells was verified by titration with Ad4 and Ad7, as positive controls. Un-inoculated cell culture tubes were included as negative controls.

(c) Polymerase Chain Reaction (PCR). PCR was performed as described by Echavarria et al (Appendix A, references 21 and 22). Detection of the amplified products was done on agarose gel electrophoresis stained with ethidium bromide using a digital microscopy documentation system (Kodak Digital Science DC 120, Kodak, Rochester, NY). DNA extraction from the samples was performed using the QIAamp blood kit (Qiagen Inc., Valencia, CA). From the eluted DNA, 10 µl of templated was used for the PCR. Both extracted and non-extracted environmental samples were tested. Each test included a negative control (water) and a positive control (Ad4); assays were accepted only when all controls gave the expected result. Investigators were blinded in regard to specimen source and culture result.

(d) Sequencing. DNA products from 3 air filters that produced the 139- bp fragment consistent with AdV were sequenced. DNA templates were purified with a PCR purification kit (QIA quick, Qiagen Inc., Valencia, CA). Sequencing reactions were performed with the Applied Biosystems International (ABI, Foster City, CA) Prism dRhodamine Terminator Cycle Sequencing Kit according to the manufacturer's specifications. Primers used for sequencing were the same as the generic PCR performed for AdV (Appendix A, reference 21). Nucleic acid sequences were determined on an ABI model 377 DNA Sequencher. Editing of derived sequences was performed with Sequencher software (Gene Codes Corporation, Ann Arbor, MI). Sequences were searched against the current Gene Bank DataBase using the BLAST algorithm (Appendix A, reference 24). Probability values (E value) for random matches of these sequences were obtained from the BLAST search.

(2) Results.

(a) A total of 65 environmental samples (59 air filters and 6 telephones) were tested by culture and PCR. A 139-bp fragment indicating the presence of AdV was amplified from 26 of 59 non-extracted air filter samples (44 %) and 22 of 59 (37%) extracted ones (Table 14, Appendix F). The results from extracted and non-extracted samples were concordant for 55 of 59 air filters (93%). None of the telephone specimens obtained on week 8 were positive for AdV by PCR. Attempts to recover AdV in cell cultures from air filters or phone surfaces were unsuccessful; all 65 samples were culture-negative.

(b) The distribution of the PCR results (from all 3 companies together) and the total number of AdV-hospitalized cases reported per week of basic training are shown in Figure 10, Appendix F. Based on the results from non-extracted samples, detection of AdV DNA in air

filters increased from week 0 to week 4 (18% to 75%; p=0.004) and declined to 1/12 (8%) on week 8 ($p< 0.001$). The peak of ARD in October-November 1998 at Fort Jackson occurred during the weeks 4 & 5 of basic training. Thus, the proportion of AdV-positive air filters by PCR coincided with the epidemic peak period. The correlation coefficients for the 8-week period were 0.86 (p=0.06, Pearson's method) and 0.90 (p=0.04, Spearman's rho method).

(c) To identify the amplified fragments, the nucleotide sequence of amplified fragments were analyzed from three samples selected randomly and confirmed to be PCR-positive with and without extraction. The sequences had highly significant homology with AdV serotype 4; the probability values (E values) for a random match were 4×10^{-29}, 8×10^{-30} and 9×10^{-36}.

(3) Discussion. Laboratory analysis confirmed the presence of Ad4 in the barracks' ventilation system. The number of Ad4-related hospitalizations was directly correlated to the proportion of filters containing Ad4 by polymerase chain reaction (PCR). The PCR may serve as a useful technique to enable us in the future to detect and quantify AdV-ARD exposure and may also enable further definition of the potential environmental effects the transmission of AdV in this setting.

c. Permanent Party (Cadre) Study.

(1) Methods. Training staff in the battalion were invited to participate in a smaller study to evaluate respiratory disease among permanent party in this battalion.

(a) Case definitions.

(i) Febrile ARD among cadre was defined as self-reported febrile illness with one or more of the following signs/symptoms: sore throat, cough, nasal congestion, rhinorrhea, hoarseness, sinus tenderness, or rales/rhonchi/wheezing.

(ii) Non-febrile ARD among cadre was defined self-reported respiratory illness with one or more of the following signs/symptoms: sore throat, cough, nasal congestion, rhinorrhea, hoarseness, sinus tenderness, or rales/rhonchi/wheezing.

(b) Demographic and medical history data. Cadre were surveyed at the beginning and end of the training cycle to evaluate respiratory symptoms during the 8-week cycle (see Appendix F). In addition medical records were retrieved and prior ARD experience (within past year) and adenovirus and influenza immunization history were extracted.

(c) Serologic data. To determine an entry and exit level of immunity, 15 ml of venous blood were drawn from each recruit and cadre at the beginning and end of the cycle. Serum samples were tested for anti-Ad4 neutralizing antibodies as described above.

(d) Data analysis. After editing for out-of-range and invalid entries, frequency cross-tabulations were evaluated for obvious correlations or risks. Odds ratios were calculated and hypotheses were tested using the Pearson's Chi-square for differences in disease experience and risk.

(2) Results.

(a) Demographic data. A total of 50 of 60 cadre assigned to the 1-28th Infantry Bn provided data and laboratory samples at the beginning of the study. Five cadre were not available at the end of the training cycle, thus, 45 cadre provided complete pre and post training information. A total of 39 (78%) male and 11 (22%) female cadre participated with a mean age of 32 (range=21-44). A majority of the cadre were drill sergeants (64%), while 24% were administrative cadre and 12% were officers. Time spend as cadre at Fort Jackson ranged from 3-29 months.

(b) Morbidity data. During the cycle, 19 (38%) of cadre reported having a respiratory illness, while 8 (16%) reported sustaining a febrile ARD (Table 15, Appendix F). Rates of respiratory illness in cadre of C company (56.3%) were higher than for cadre assigned to A (28.6%) or D (40.0%) companies, though not statistically significant. Collectively, the cadre experienced 123 sickdays and missed 21 workdays due to respiratory illness. Of 44 medical records available for review, 16 (36%) had at least one documented visit to a health care provider for an ARD-like illness in 1997-98; there were no hospitalizations recorded among this group. AdV vaccination history from medical records revealed that 19 (43%) received the vaccine and 25 (57%) did not. Prior vaccination history was not associated with a decrease in respiratory disease rates.

(c) Serology. Forty-five pairs of blood samples (pre- and post-training) were available for serological analysis (Table 16). A total of 34 (75.5%) were immune or partially immune to Ad4, while 11 (24.5%) were non-immune to Ad4. All three cadre who seroconverted were initially non-immune (titer < 1:4) and 2 of the 3 had not received AdV vaccine in the past (1 with unknown data). All 3 seroconverters also reported having had a respiratory illness during the cycle (one febrile ARD, 2 afebrile ARD). Prior vaccination history was found to correlate with a higher level of immunity; 11 (85%) of 13 vaccinated cadre were immune at baseline compared to 11 (61%) of 18 unvaccinated personnel (P=0.01, Fisher's exact test). In addition, lack of immunity (titer < 1:4) was also found to correlate with Ad4 infection; 3 (27%) of 11 non-immune cadre seroconverted to anti-Ad4 compared to none of 34 immune cadre (P=0.01, Fisher's exact test).

(3) Discussion. The impact of adenovirus among non-recruit populations should not be overlooked. The results of this small investigation suggest that permanent party personnel who have not been immunized previously with AdV vaccine are also at risk for adenovirus infections given a lower level of immunity.

5. RECOMMENDATIONS.

a. Immunization. The optimal measure for preventing outbreaks due to adenoviruses is immunization, as demonstrated through successful control through the adenovirus immunization program and resulting epidemics with vaccine cessation. In the absence of vaccine, military recruits are vulnerable to adenovirus infections, just as they were during the pre-vaccine era. Until vaccines are once again available, there is a need for other approaches to inhibit the spread and minimize the costs of AdV infections among trainees. In addition to recruits, it may also be prudent to consider immunization of permanent party (cadre) personnel upon arrival on-post in order to decrease their susceptibility to infection with adenoviruses.

b. Non-vaccine acute respiratory disease interventions (NOVARDIs). Non-vaccine interventions are available to assist in prevention of acute respiratory diseases. Although many are discussed below, none of these measures have been proven to prevent transfer of adenoviruses in controlled studies.

(1) Clean hands. Thorough hand washes reduces nosocomial and enteric infections, but has not been proven to reduce respiratory diseases. The Navy's "Stop Cough" program, implemented in FY96 at Great Lakes included 5 daily, mandatory hand washes, hand washing education for recruits and trainers, mandatory liquid soap in barracks and hygiene as a part of personnel inspections. When vigorously enforced, this program showed a 45% reduction in overall respiratory illness rates. Use of iodinated hand-wipes, while not directly preventing or ameliorating disease, may reduce hand-to-fomite or hand-to-hand disease transfer.

(2) Bunk spacing. Army Regulation 415-50 requires 72 sq. ft of net floor space (bed, locker, and circulation) per soldier. Avoiding double bunking, and increasing the space between sleeping recruits may reduce respiratory illnesses among trainees.

(3) Sleeping head-to-toe. Head-to-toe sleeping arrangements are already universal at Fort Jackson, even though this method has not been proven successful. This method stems from the assumption that respiratory infection transfer occurs chiefly in the barracks.

(4) Cohorting of ill recruits. Cohorting mildly sick individuals have been proposed, though it may be operationally unacceptable.

(5) Personal Protective Equipment. Use of masks and/or cotton gloves have been suggested, but are considered compliance problems. There is no strong study data that proves that use of such equipment may decrease the risk of AdV infection among recruits.

c. Therapeutic measures. Benzathine penicillin (bicillin), multi-vitamins, zinc lozenges and high dose vitamin C have been used to treat viral infections, but have not proven successful or recommended in AdV infections. When bicillin was routinely given at the reception station at

Fort Leonard Wood, ARD rates were lower than expected. Although this prophylaxis is aimed mainly at bacterial infections, there may be a, yet unexplained, beneficial effect on AdV incidence.

d. Engineering measures. Several engineering approaches have been explored, including: 1) indoor air dilution; 2) UV light in air-ducts; 3) indoor temperature and humidity control; and, 4) change in building designs. Frequent filter changes and increasing air exchanges may be effective in preventing inter-unit or inter-floor transmission.

e. AdV Countermeasures and Preparation. In an outbreak situation, training personnel should emphasize hygiene, and reduce crowding when possible. In extreme ARD outbreaks, acquision of additional barracks space, supplemental staff or delay of new recruits may be necessary. Medical staff at each training installation should consider contingency plans that

(1) Obtaining additional medical staff (i.e., activating reservists, requesting staff from other MTFs or requesting increased staff resources from their Regional Medical Command or the MEDCOM).

(2) Securing additional clinic space and resources to see ARD patients.

(3) Securing additional hospital space and resources for very ill ARD patients (e.g., setting up for an expanded ARD ward capability).

(4) Promptly reporting the outbreak within the preventive medicine community, and requesting assistance with pathogen identification and controls efforts.

(5) Alerting the military recruit training community to implement efforts to reduce ARD transmission, i.e., enforced hygiene and handwashing, and avoiding over-crowding.

f. Surveillance Vigilance and Emphasis.

(1) Weekly surveillance for ARD should be considered the most critical step in addressing the adenovirus challenge. Prompt, accurate tracking of ARD rates allows health professionals to see when outbreaks are beginning, and to assess the effects of any intervention measures. Appropriate adenovirus surveillance should include tracking of general ARD, as well as sampling for specific pathogens among hospitalized ARD cases. Such a system is already in effect at Fort Jackson and other Army and Navy basic training posts. Two historical references that can be used for guidance in setting up a surveillance program include:

(a) MEDCOM Memorandum, 25 Jan 1995, SUBJECT: Acute Respiratory Disease (ARD) and Adenovirus Surveillance Programs.

(b) OTSG Memorandum, 27 Dec 1989, SUBJECT: 1989-1990 Acute Respiratory Disease (ARD) Surveillance Program.

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APPENDIX A

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APPENDIX B

EPICON TASKING LETTER

ATZJ-CG 2 SEP 98

MEMORANDUM FOR BG Patrick D. Sculley, Commander, USA Center for Health Promotion and Preventive Medicine, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5422

SUBJECT: Request for Epidemiologic Consultative (EPICON) Assistance

1. Request your assistance in obtaining support for a study of the epidemiology of acute respiratory disease due to adenovirus in recruits at Fort Jackson. Due to the lack of availability of adenovirus type 4 vaccine this fall and winter, I expect a significant negative impact from these infections with major dysfunction in BCT.

2. The data to be collected should include: 1) baseline information on recruits' susceptibility to this threat; 2) a definition of risk factors that predispose recruits to infection/illness; 3) an evaluation of environmental parameters that can influence adenovirus transmission; and, 4) an outline of preventive interventions to assist in the control of this problem.

3. I understand that your team has experience from similar studies conducted at Fort Jackson during last year's adenovirus epidemic. My POC for this action is Colonel William A. Bester, MEDDAC Commander, at DSN 734-2284, Comm (803) 751-2284, or FAX (803) 751-2784.

JOHN A. VAN ALSTYNE
Major General, U.S. Army
Commanding

CF:
Commander
Southeast Regional Medical Command
Fort Gordon, Georgia 30905-5650

Commander
USA MEDDAC
4500 Stuart Street
Fort Jackson, South Carolina 29207-5720

Surgeon
TRADOC (ATTN: ATMD)
Fort Monroe, Virginia

Chief, Preventive Health Services Division
MEDCOM (ATTN: MCHO-CL-W)
Fort Sam Houston, Texas 78234

APPENDIX C

RECRUIT ENTRY AND EXIT QUESTIONNAIRES

37647

Fort Jackson Baseline (Entry) Questionnaire

(Please use black ink pen/marker to complete survey. THANKS!)

1. Last Name

2. First Name **MI**

3. Today's Date (MM/DD/YY) ___/___/___

4. Gender
___ Male
___ Female

5. Age

6. Social Security Number ___-___-___

7. Date of Birth (MM/DD/YY) ___/___/___

8. Race
___ African American/Black
___ Caucasian/White
___ Non-white Hispanic
___ Asian
___ Other

9. State of Birth

10. The state where you lived most of your life:

Please put a check mark or X next to correct response.

11. When did you start smoking cigarettes?
___ Never Smoked
___ Within past 12 months
___ 1-5 years ago
___ 6 years or more

12. Before basic training, how many cigarettes did you usually smoke per day?
___ None
___ Less than 1 pack per day
___ 1-2 packs a day
___ 3 or more packs per day

13. Before basic training, did you live with someone who smoked in the home? ___ Yes ___ No

14. If yes, how many years did you live with the smoker?

15. Check if you have or had:
___ Asthma
___ Respiratory allergies/Hay fever
___ Flu

16. Have you had the flu in past 30 days? ___ Yes ___ No

17. Mark the box next to any symptom that you have RIGHT NOW:

___ Fever/Chills	___ Diarrhea
___ Sore throat	___ Dizziness
___ Cough	___ Wheezing
___ Stuffy/Runny nose	___ Sinus pain
___ Hoarse voice	___ Headache
___ Vomiting/Nausea	___ Watery/Runny eyes

18. Have you been sick with any of the above symptoms during the past 7 days? ___ Yes ___ No

Do Not Write Below This Line

Physical findings: ___ Pharyngitis ___ Rhinorrhea ___ Sinus tenderness

Swabbed: ___ Yes ___ No **Status:** ___ Case ___ Control

59381

Fort Jackson Adenovirus Exit Questionnaire

(Please use black ink pen/marker to complete survey. THANKS!)

ID# 336

1. **Last Name**

3. **Today's Date (MM/DD/YY)** ☐☐ / ☐☐ / ☐☐

2. **First Name**

4. **Social Security Number** ☐☐☐ - ☐☐ - ☐☐☐☐

5. Which of the following symptoms did you have during basic training? ***(Place an 'X' in all boxes that apply)***

☐ fever/chills ☐ cough ☐ hoarse voice ☐ watery/runny eyes

☐ sore throat ☐ stuffy/runny nose ☐ sinus pain ☐ wheezing/difficulty breathing

6. How important are each of the following in getting sick with any of the symptoms listed above? ***(Place 'X' in box of correct responses)***

	Very important	Important	Slightly Important	Not Important	Don't Know
Not washing hands	☐	☐	☐	☐	☐
Crowded barracks	☐	☐	☐	☐	☐
Not covering mouth when coughing	☐	☐	☐	☐	☐
Poor air circulation/ventilation	☐	☐	☐	☐	☐
Dirty pillows/blankets	☐	☐	☐	☐	☐
Physical stress/being tired	☐	☐	☐	☐	☐
Poor diet/nutrition	☐	☐	☐	☐	☐

7. Were any of the following people sick with any of the symptoms listed in Question #5? ***(Place 'X' in box of correct responses)***

	Yes	No	Don't Know	*If yes, was he/she sick: (Circle correct response)*			
my buddy	☐	☐	☐	before me	after me	same time as me	I wasn't sick
any member of my squad	☐	☐	☐	before me	after me	same time as me	I wasn't sick
my bunkmate	☐	☐	☐	before me	after me	same time as me	I wasn't sick
my drill sergeant	☐	☐	☐	before me	after me	same time as me	I wasn't sick

8. During most or all of basic training, did you sleep: ***(Place 'X' in box of correct responses)***

☐ in the top bunk ***OR*** ☐ in the bottom bunk

☐ closer to the bathroom ***OR*** ☐ closer to the front door

☐ head toward the window ***OR*** ☐ head toward center of room ***OR*** ☐ bunk was in the middle of room

Please circle correct responses.

9. How many times a day did you wash your hands (including showers)?

1 2 3 4+

10. Was there always soap in the bathrooms to wash your hands?

Yes No Don't Know

11. Was there a handwashing stand with soap in the dining/chow area?

Yes No Don't Know

If yes, did you use it regularly? Yes No

12. Were there handwashing stands with soap in the field training areas?

Yes No Don't Know

If yes, did you use it regularly? Yes No

13. Did you usually cover your mouth when coughing or sneezing?

Yes No

APPENDIX D

WEEKLY DIARY CARD

Respiratory Disease Survey Card

Date: ____/____/98 to ____/____/98

Name _____ SSN_____

Sex: ☐ M / ☐ F Week of Training:_____ Company_____ Platoon_____ Squad_____

Did you visit sick call this past week? Yes / No ***If yes***, when? ____/____/98 (Day of wk: _____)

Did you miss any training because of this illness? Yes / No If yes, how many hours? _____

Check **YES**, if you had these symptoms in the **past week**. Check the days you had the symptom.

	YES		Mon	Tue	Wed	hurs	Fri	Sat	Sun
Fever/Chills									
Sore throat									
Cough									
Hoarse voice									
atery/Runny eyes									
tuffy/Runny nose									
Sinus pain									
Headache									
Wheezing									
Dizziness									
Nausea/Vomiting									
Diarrhea									

APPENDIX E

Fort Jackson Respiratory Disease Questionnaire

Today's Date: _____/_____/__1998__ **Interviewer Initials:** _____
Month Day Year

Name_____
SSN_____

Birth Date: _____/_____/_____ Age_____ Sex: ☐ M / ☐ F
Month Day Year

Rank_____ BN_____ Co_____ Platoon_____ Squad_____ Week of Training:____

BCT: (Has ever been to basic training) ☐ Yes / ☐ No If yes, where? _____ year_____

First visit? ☐ Yes / ☐ No ***If No***, date of first visit : _____/_____/_____
Month Day Year

Main Complaint(s) at ***today's*** visit: _____

When did you first start feeling sick (date of onset of symptoms)?_____ Time (24-hr):____

Did you go to sick-call ***for this problem*** before today? ☐ Yes / ☐ No

Did you take any medications for this illness? ☐ Yes / ☐ No

How much duty time have you missed due to this illness? Hours_____ **or** Days_____

Signs and Symptoms (check all that apply):

☐ Fever	☐ Cough	☐ Runny/Stuffy Nose
☐ Headache	☐ Trouble breathing	☐ Sore Throat/Trouble swallowing
☐ Runny Eyes	☐ Muscle Aches	☐ Earache/Trouble hearing
☐ Sinus pain	☐ Ringing in ears	☐ Stiff neck
☐ Dizziness	☐ Hoarseness	☐ Wheezing
☐ Chest pain/tickling when breathing		☐ Other _____

Highest Oral Temperature: _____°F

Have you ever had: ☐ Allergies/Hay fever ☐ Asthma

Did you smoke before basic training? ☐ Yes / ☐ No

If **yes**, how much did you smoke? ☐ Less than 1 pack/day ☐ 1-2 packs/day ☐ 3 or more packs/day

When did you start smoking? ☐ In past 12 months ☐ 1-5 yrs ago ☐ 6 or more years ago

Quit Date: _____/_____/_____

APPENDIX F

CADRE ENTRY AND EXIT QUESTIONNAIRES

37647

Fort Jackson Baseline (Entry) Questionnaire

(Please use black ink pen/marker to complete survey. THANKS!)

1. Last Name

2. First Name **MI**

3. Today's Date (MM/DD/YY) ___/___/___

4. Gender ___ Male ___ Female

5. Age

6. Social Security Number ___-___-___

7. Date of Birth (MM/DD/YY) ___/___/___

8. Race

___ African American/Black
___ Caucasian/White
___ Non-white Hispanic
___ Asian
___ Other

9. State of Birth

10. The state where you lived most of your life:

Smoking Status: _____Current Smoker _____ Ex-Smoker _____Never Smoked

11. When did you start smoking?

_____ Never Smoked
_____ Within the past 12 months
_____ 1-5 years ago
_____ 6 years or more

12. How much do you usually smoke per day?

_____ None
_____ Less than 1 pack per day
_____ 1-2 packs per day
_____ 3 or more packs per day

13. Do you live with someone who smokes in the home? _____ Yes _____ No

14. If yes, how many years have you lived with the smoker? _____

15. Check if you have or had:

_____ Asthma
_____ Respiratory allergies / Hay fever
_____ Flu

16. Have you had the flu in the past 30 days? _____ Yes _____ No

17. Mark the box next to any symptom that you have RIGHT NOW:

_____ Fever / Chills	_____ Hoarse voice	_____ Wheezing
_____ Sore Throat	_____ Vomiting / Nausea	_____ Sinus Pain
_____ Cough	_____ Diarrhea	_____ Headache
_____ Stuffy / Runny Nose	_____ Dizziness	_____ Watery/Runny Eyes

18. Have you been sick with any of the above symptoms during the past 7 days? ___ Yes ___ No

Basic Training: Where _____ Start date _____
Month Year

Do Not Write Below This Line

Physical findings: ___ Pharyngitis ___ Rhinorrhea ___ Sinus tenderness

Swabbed: ___ Yes ___ No **Status:** ___ Case ___ Control

FORT JACKSON CADRE EXIT QUESTIONNAIRE

Today's Date (MM/DD/YY) ___/___/_98

Last Name_____ RANK _____

First Name_____ BN _____ CO_____

Are you a Drill Sergeant with BN 1-28? ❑ Yes ❑ No

How long have you been a Drill Sergeant/Cadre at Fort Jackson? _____ months

Start date as Drill Sergeant/Cadre at Fort Jackson (MM/YY) _____/_____

Smoking status: ❑ Never smoked ❑ Current Smoker ❑ Ex-Smoker
Quit date (MM/YY) _____/_____

During this cycle of training, have you been sick with a flu-like illness? ❑ Yes ❑ No

Check the symptoms you had during this flu-like illness.

❑ Fever/Chills	❑ Hoarse voice	❑ Wheezing
❑ Sore Throat	❑ Vomiting/Nausea	❑ Sinus Pain
❑ Cough	❑ Diarrhea	❑ Headache
❑ Stuffy/Runny Nose	❑ Dizziness	❑ Watery/Runny eyes

Did you see a health care provider for your illness? ❑ Yes ❑ No
Were you admitted to the hospital for your illness? ❑ Yes ❑ No

How many days did your illness last? _____ days
How many days of duty did you miss because of this flu-like illness? _____ days

At home, do you live (or room) with cadre, such as a Drill Sergeant, who has daily contact with soldiers in basic training? ❑ Yes ❑ No

How many times a day do you wash your hands (include showers)? ❑ 1 ❑ 2 ❑ 3 ❑ 4+

Was there always soap in the BN 1-28 latrines to wash your hands? ❑ Yes ❑ No ❑ Don't Know

Was there a handwashing stand with soap in the chow area? ❑ Yes ❑ No ❑ Don't Know

Were there handwashing stands with soap in the field training areas? ❑ Yes ❑ No ❑ Don't Know
If yes, did you use them regularly? ❑ Yes ❑ No ❑ Don't Know

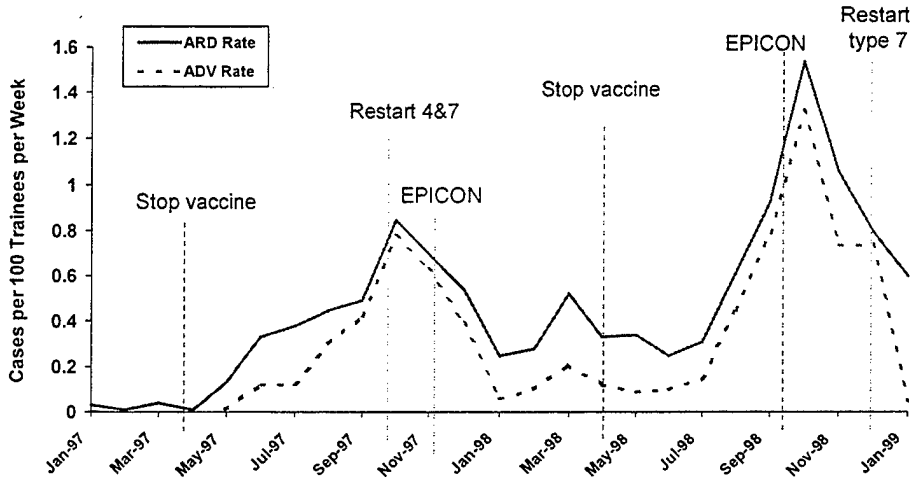
Did you usually cover your mouth when coughing or sneezing? ❑ Yes ❑ No ❑ Don't Know

Turn page over and provide any comments that you feel are important.
Thank You.

APPENDIX G

TABLES AND FIGURES

Figure 1: Average Weekly ARD and ADV Rates, Ft Jackson, SC Jan97-Jan98



*ADV rates provided by Naval Health Research Center, San Diego

Figure 2: Adenovirus Infection Rates at Basic Training Sites Reported by Naval Health Research Center July 1998-December 1999

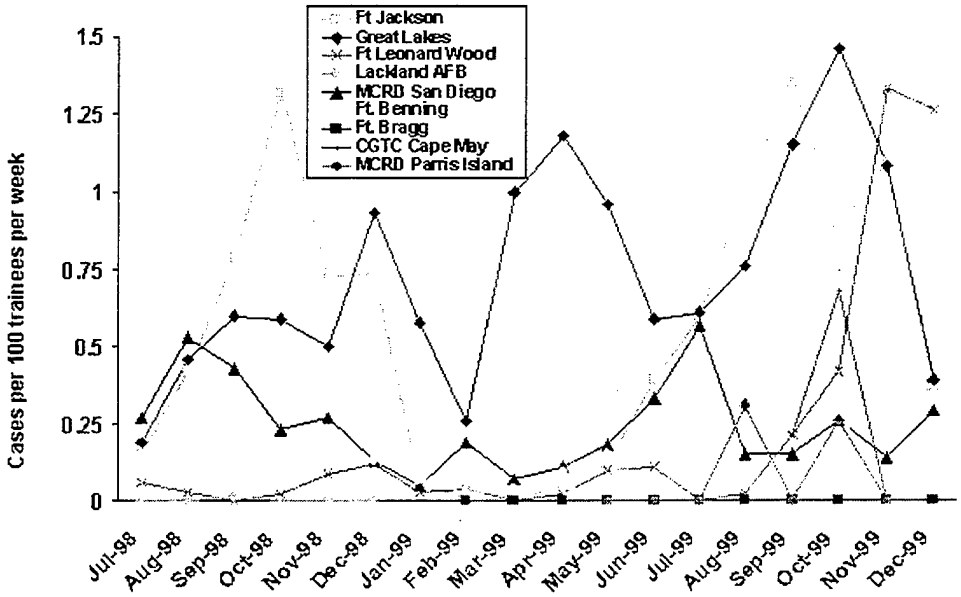


Figure 3. Starship barracks diagram, 1-28th Infantry Battalion, Fort Jackson, SC

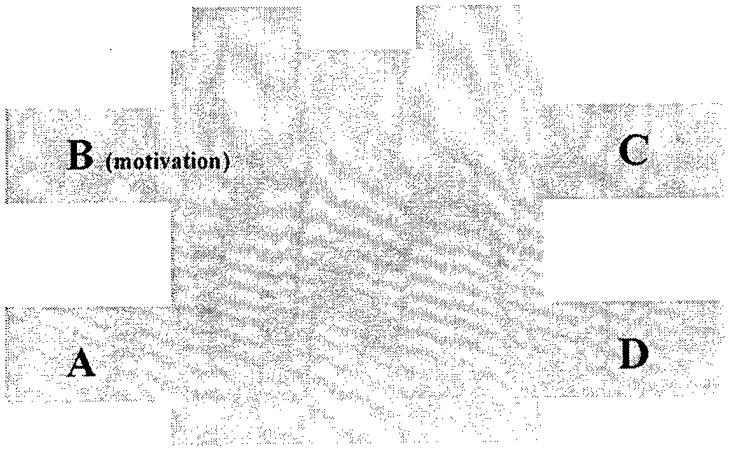


Table 1. Weekly Cohort Population, by Company and Gender

WK	A			C			D			BN
	Female	Male	Total	Female	Male	Total	Female	Male	Total	**Total**
0	111	116	227	106	119	225	56	170	225	**678**
1	111	116	227	106	119	225	56	170	225	**678**
2	106	115	221	103	118	221	55	170	221	**667**
3	104	112	216	97	114	221	52	163	221	**642**
4	101	108	209	93	111	204	51	154	204	**618**
5	101	108	209	90	107	197	50	151	197	**607**
6	100	108	208	90	107	197	49	149	197	**603**
7	100	106	206	88	107	195	47	146	195	**594**

Table 2. Selected demographic characteristics of recruit population by training unit

Variable	A company (n=227) No. (%)	C company (n=225) No. (%)	D company (n=226) No. (%)	Total (n=678) No. (%)
Gender				
Female	111 (48.9)	106 (47.1)	56 (24.8)	273 (40.3)
Male	116 (51.1)	119 (52.9)	170 (75.2)	405 (59.7)
Race/Ethnicity				
White	97 (42.7)	107 (47.6)	111 (49.1)	315 (46.5)
Black	87 (38.3)	74 (32.9)	62 (27.4)	223 (32.9)
Hispanic	20 (8.8)	28 (12.4)	35 (15.5)	83 (12.2)
Other	23 (10.1)	16 (7.1)	18 (8.0)	57 (8.4)
Mean (median) age	20.4 (19)	20.7 (19)	20.5 (19)	20.5 (19)
Smoking status[a]				
Non-smoker	137 (60.4)	118 (52.4)	133 (58.8)	388 (57.2)
Current Smoker	68 (30.0)	79 (35.1)	80 (35.4)	227 (33.5)
Former Smoker	22 (9.7)	28 (12.4)	12 (5.3)	62 (9.1)
US region lived most of life (states)				
New England/Mid-Atlantic (ME,NH,VT,MA,RI,CT,NY,NJ,PA)	38 (16.7)	36 (16.1)	45 (19.9)	119 (17.6)
North Central (OH,IN,IL,MI,WI,MN,IA,MO,ND,SD,NE,KS)	43 (18.9)	37 (16.6)	30 (13.3)	111 (16.3)
South Atlantic (DE,MD,DC,VA.WV,NC,SC,GA,FL)	55 (24.2)	48 (21.1)	46 (20.4)	148 (21.9)
South Central (KY,TN,AL,MS,AR,LA,OK,TX)	40 (17.6)	40 (17.9)	36 (15.7)	117 (17.2)
Mountain/Pacific (MO,ID,WY,CO.NM,AZ,UT,NV,WA, OR,CA,AK,HI)	35 (15.4)	45 (19.7)	44 (19.5)	123 (18.2)
Outside of the United States	16 (7.0)	19 (8.5)	25 (11.1)	60 (8.9)

[a]One recruit with unknown smoking status in D company

Figure 4. Status of Cohort, 1-28 IN BN, Ft. Jackson, SC, October-November 1998

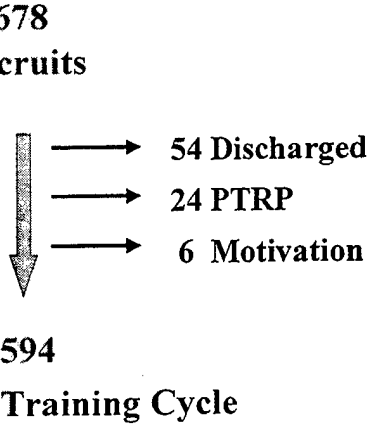


Table 3. Self-reported febrile ARD, by company and gender.

Unit assigned to		Attack Rate (%)
A company		48.9
	Male	43.1
	Female	55.0
C company		53.3
	Male	51.3
	Female	55.7
D company		54.4
	Male	54.1
	Female	55.4
Total		52.2
	Male	50.1
	Female	55.3

Figure 5. Weekly Self-Reported Febrile ARD by Company, 1-28th Infantry BN, Fort Jackson, SC

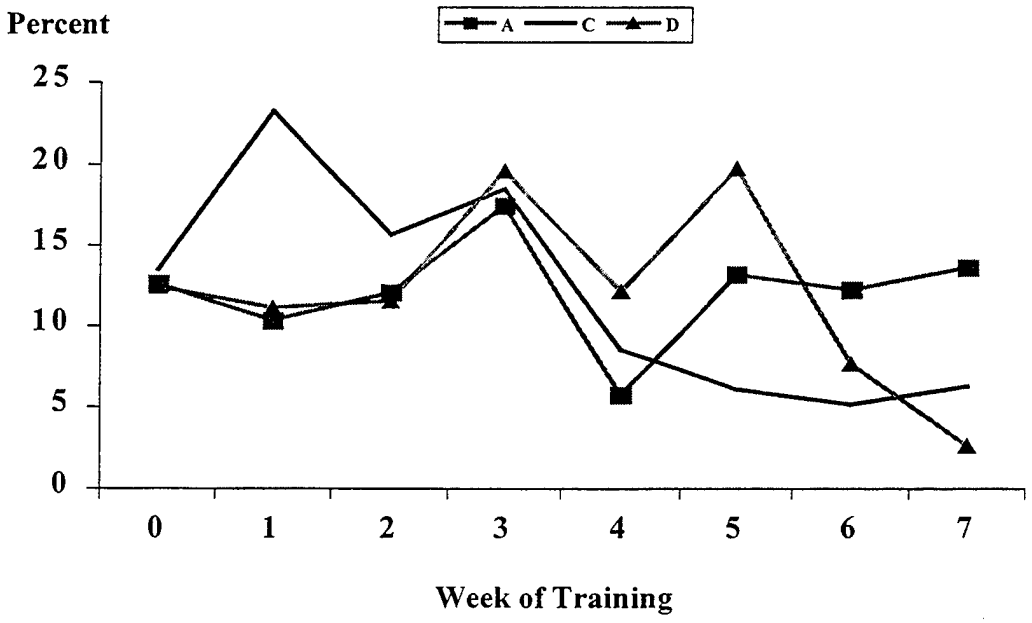


Table 4. Number of hospitalizations and hospitalization rate by company

Company Assigned to	Number of Hospitalizations	Hospitalization Rate (%)
A	23	10.1
C	47	20.9
D	45	19.9
Total	115	17.0

Figure 6. ARD Hospitalization Rate by Week of Training, 1-28th Infantry Bn, Fort Jackson, SC, 1998

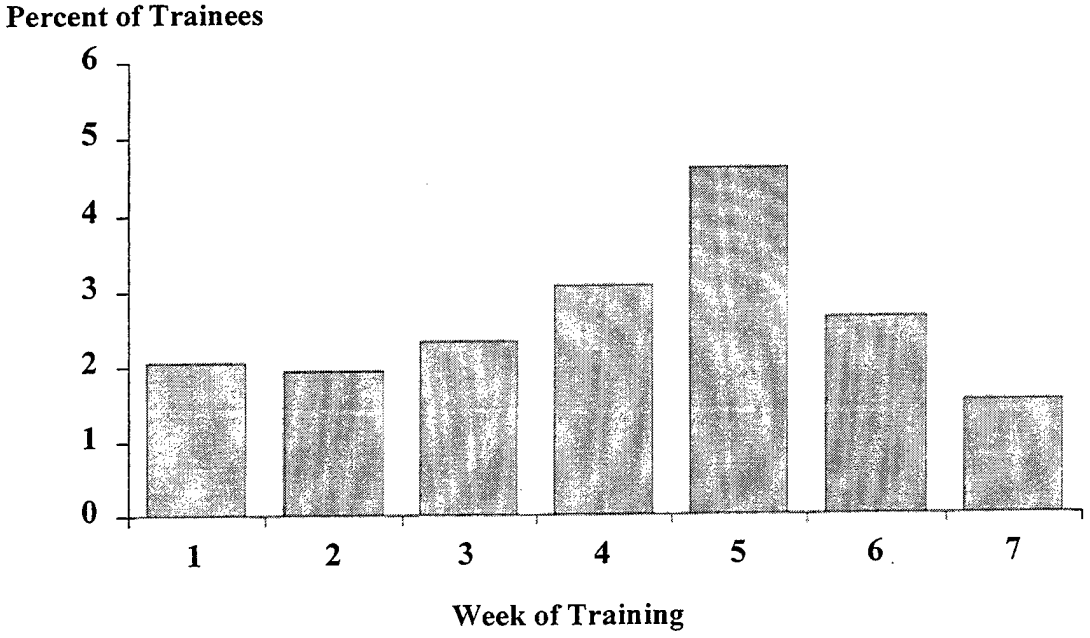


Table 5. Distribution of symptoms among 115 hospitalized recruits, 1-28th Infantry Bn, Fort Jackson, SC, 1998.

Symptom	A company (n=23) No. (%)	C company (n=47) No. (%)	D company (n=45) No. (%)	Total (n=115) No. (%)
Fever/Chills	23 (100)	47 (100)	45 (100)	115 (100)
Sore Throat	22 (96)	46 (98)	40 (89)	108 (94)
Cough	22 (96)	44 (94)	41 (91)	107 (93)
Runny Nose	22 (96)	43 (91)	37 (82)	102 (89)
Headache	22 (96)	38 (81)	38 (84)	98 (85)
Muscle Aches	18 (78)	40 (85)	38 (84)	96 (83)
Hoarseness	15 (65)	40 (85)	36 (80)	91 (79)
Dizziness	18 (78)	37 (79)	28 (62)	83 (72)
Chest Pain	12 (52)	24 (51)	24 (53)	60 (52)
Sinus Pain	13 (56)	19 (40)	25 (56)	57 (50)
Stiff Neck	9 (39)	21 (45)	27 (60)	57 (50)
Difficulty Breathing	13 (56)	19 (40)	17 (38)	49 (43)
Ear Aches	14 (61)	19 (40)	14 (31)	47 (41)
Watery/Runny Eyes	4 (17)	22 (47)	18 (40)	42 (37)
Wheezing	6 (26)	10 (21)	13 (29)	29 (25)
Ringing Ears	5 (22)	9 (19)	10 (22)	24 (21)

Table 6. Adenovirus type 4 neutralizing antibody responses in male and female recruits hospitalized with febrile ARD, Fort Jackson, SC, Fall 1998

Gender	No. tested	Number (%) 4-fold rises	Number (%) seropositives[a]	Number (%) 4-fold rises among seronegatives[b]
Males	55	48 (87)	8 (15)	47 (100)[c]
Females	28	21 (75)	2 (7)	21 (81)[c]
Totals	83	69 (83)	10 (12)	68 (93)

[a] Acute serum anti-Ad4 neutralization titer $\geq$ 1:32.
[b] Acute serum anti-Ad4 neutralization titer < 1:16, 47 males and 26 females.
[c] $P < 0.01$, by Fisher's exact test (two-tailed) for comparison of males versus females.

Table 7. Adenovirus neutralizing antibody responses of selected febrile ARD recruits without an adenovirus type 4 isolate, Fort Jackson, SC, Fall 1998.

Isolate	No. recovered	No. with rise/No tested (%)			
		ADV4	ADV3	ADV21	ADV7a
AdV3	7	3/6 (50)*	6/6 (100)	0/6 (0)	5/6 (83)**
AdV21	2	0/1 (0)	0/1 (0)	1/1 (100)	0/1 (0)
None	10	2/10 (20)	0/10 (0)	0/10 (0)	0/10 (0)
Totals	19	5/17 (29)	6/7 (35)	1/17 (6)	5/17 (29)

* Rises probably due to dual infection with types 3&4.

**Rises to ADV 7a: heterotypic response known to occur between types 3 & 7.

Figure 7. Causes of ARD as Determined by Viral Isolates* from Throat Swabs of 97 Hospitalized Recruits, 1-28 IN BN, Fort Jackson, SC, 1998

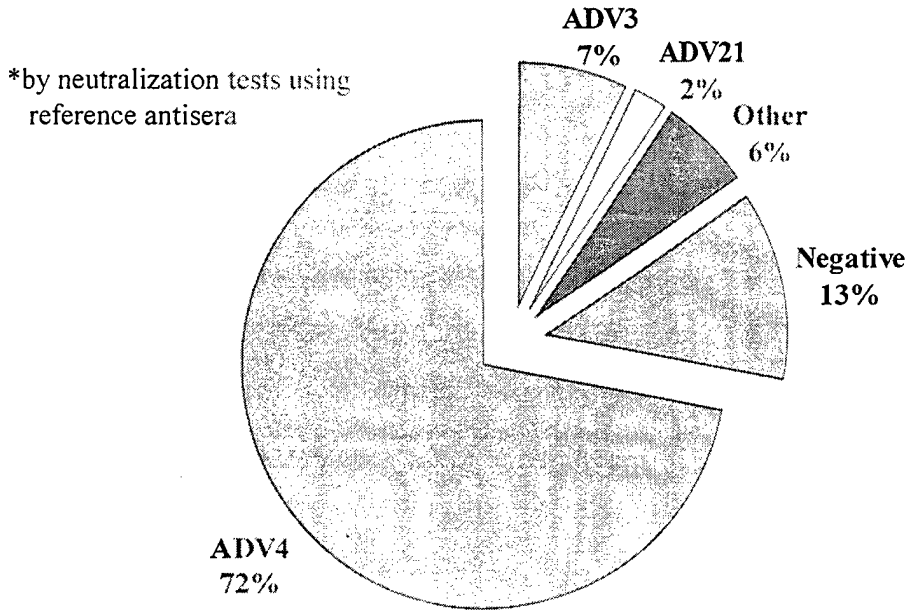


Figure 8. ADV Throat Culture Isolates by Week of Hospitalization, Ft. Jackson 1998

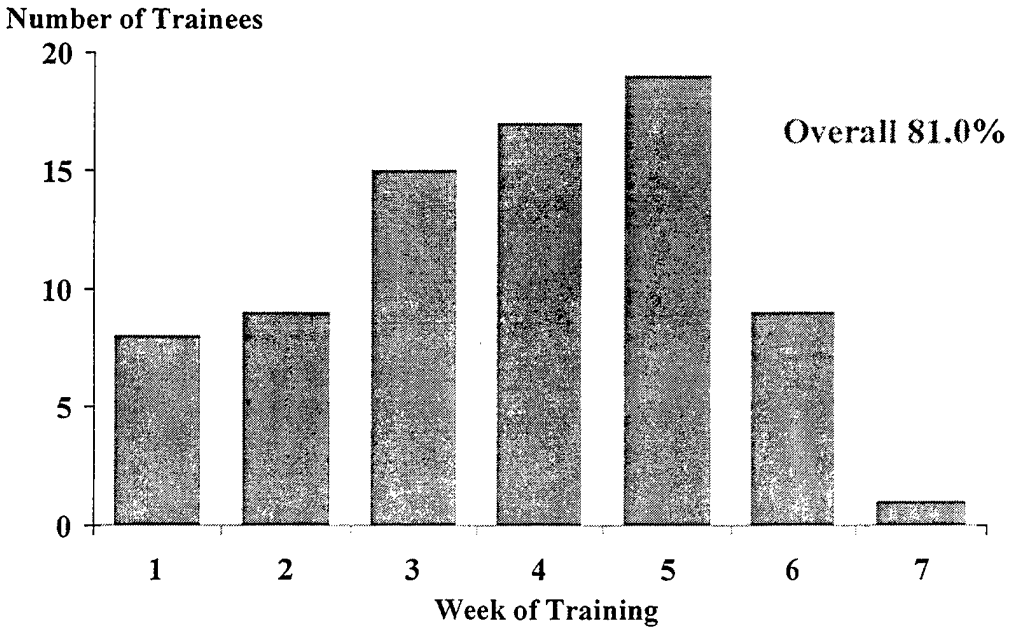


Table 8. Self-reported handwashes per day, by company (%)
1-28th Infantry Bn, Fort Jackson, SC 1998.

Handwashes per day*	A	C	D	Total
4 or more	70.4 (64.0-76.8)	56.6 (49.3-64.032)	42.9 (35.7-50.0)	314
3 or less	29.6 (23.2-36.0)	43.4 (36.0-50.7)	57.1 (50.0-64.3)	237
Total (N)	196	173	182	551

*Includes Showering

Table 9. Description of case-control study population

Variable		Hospitalized (n= 83)		Non-hospitalized (n= 166)	
		No.	%	No.	%
Age	Mean (median)	19.3 (19)	N/A	19.5 (19)	N/A
Gender	Male	54	65.1	108	65.1
	Female	29	34.9	58	34.9
Training unit (company)	A	18	21.7	36	21.7
	C	30	36.1	60	36.1
	D	35	42.2	70	42.2
Race	White	42	50.6	77	46.4
	Black	23	27.7	55	33.1
	Other [a]	18	21.7	34	20.5
Smoker[b]	Yes	31	37.3	56	33.9
	Former [c]	9	10.8	12	7.2
	No	43	51.8	98	58.8
Smoking member at home[b]	Yes	35	42.2	80	48.2
	No	48	57.8	85	51.2
Region of birth[d]	Tropical[e]	14	16.9	27	16.3
	Temperate[f]	69	83.1	137	82.5
Growing-up Region[g]	Tropical[e]	8	9.7	17	10.2
	Temperate[f]	75	90.3	148	89.2

[a]Hispanic, Asian, Pacific Islander, Other
[b]One non-hospitalized recruit with unknown personal history and household member smoking data
[c]Quit smoking before arriving at basic training
[d]Region recruit was born in
[e]All countries in Central/South America, Africa, Pacific, Phillippines; Florida and Hawaii
[f]Europe, Japan, Korea and all US States except Florida and Hawaii
[g]Region recruit spent majority of life to-date

Table 10. Seroconversion and initial anti-Ad4 immunity

Antibody status	Hospitalized (n= 83)		Non-hospitalized (n= 166)	
	No.	%	No.	%
Four-fold seroconversion				
Yes	69	83.1	82	49.4
No	14	16.9	84	50.6
Entry anti-Ad4 neutralizing antibody titer (≥1:32)				
Yes	10	12.0	43	25.9
No	73	88.0	123	74.1

Figure 9. Seroconversion rates (%) and baseline titers

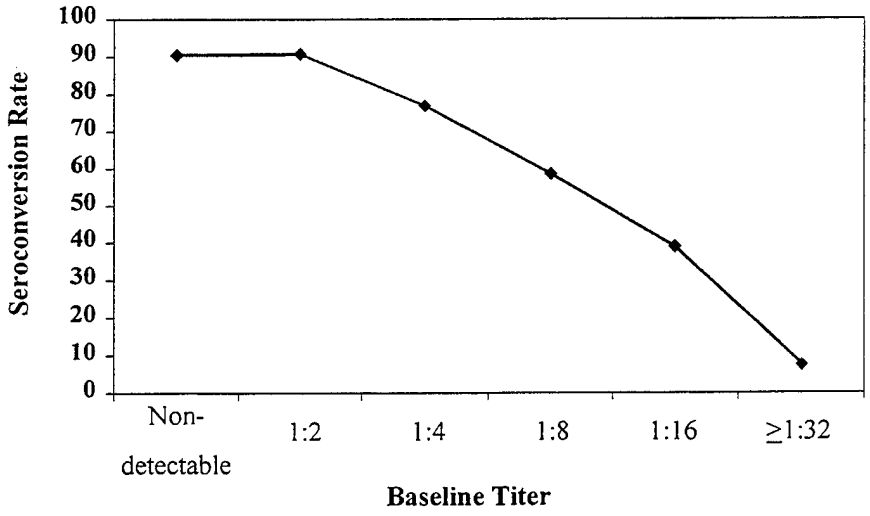


Table 11. Anti-Ad4 immunity and associated demographic factors

Variable		No. Seropositive[a] (n=53)	No. Tested (n=249)	Seropositivity Rate (%)	OR (95%CI)	P Value
Age	< 20	33	172	19.1	0.68	0.23
	≥ 20	20	77	26.0	(0.34, 1.34)	
Gender	Male	36	162	22.2	1.18	0.62
	Female	17	87	19.5	(0.59, 2.36)	
Training unit (Company)	A	16	54	29.6	C and D vs. A: 0.56 (0.27, 1.17)	C and D vs. A: 0.09
	C	18	90	20.0		
	D	19	105	18.1		
Race	Non-white[b]	29	130	22.3	1.14	0.68
	White	24	119	20.2	(0.59, 2.18)	
Prior smoking history[c]	Yes	21	108	19.4	0.85	0.60
	No	31	140	22.1	(0.44, 1.65)	
Smoking member at Home[c]	Yes	28	115	24.3	1.39	0.29
	No	25	133	18.8	(0.72, 2.67)	
Region of birth[d]	Tropical[e]	11	41	26.8	1.43	0.36
	Temperate[f]	42	206	20.4	(0.62, 3.28)	
Growing- up region[g]	Tropical[e]	10	25	40.0	2.79	0.02
	Temperate[f]	43	223	19.3	(1.08, 7.17)	

NOTE. OR, crude odds ratio; 95% CI, 95 percent confidence interval.

[a]High initial titer (≥1:32)
[b]Black, Hispanic, Asian, Pacific Islander, Other
[c]One seropositive with unknown smoking history; one seronegative with unknown household member smoking data
[d]Region recruit was born in; 2 with unknown data
[e]All countries in Central/South America, Africa, Pacific, Phillippines; Florida and Hawaii
[f]Europe, Japan, Korea and all US States except Florida and Hawaii
[g]Region recruit spent majority of life to-date; 1 with unknown data

Table 12. Risk factors for Ad4 infection in univariate and multivariate analysis

Risk factors	Number/total (%)		OR (95% CI), Univariate analysis	AOR (95% CI), Multivariate analysis
	When risk factor present	When risk factor absent		
Age (<20 years old)	110/172 (64.0)	41/77 (53.2)	1.56 (0.87, 2.79)	3.58 (1.16, 11.03)[e]
Male gender	109/162 (67.3)	42/87 (48.3)	2.20 (1.25, 3.89)[f]	3.64 (1.76, 7.52)[f]
Training unit (A Company)	30/54 (55.6)	121/195 (62.1)	0.76 (0.40, 1.47)	0.80 (0.32, 2.03)
Non-white race[a]	79/130 (60.8)	72/119 (60.5)	1.01 (0.57, 1.74)	1.38 (0.50, 3.80)
Prior smoking history	67/108 (62.0)	84/140 (60.0)	1.09 (0.63, 1.88)	1.25 (0.60, 2.62)
Smoking member at home	63/115 (54.8)	88/133 (66.2)	0.62 (0.36, 1.07)	0.70 (0.35, 1.41)
Tropical region of birth[b]	25/41 (61.0)	126/206 (61.2)	0.99 (0.47, 2.09)	0.72 (0.18, 2.78)
Tropical growing-up region[c]	14/25 (56.0)	137/223 (61.4)	0.80 (0.32, 1.99)	2.10 (0.36, 12.13)
High initial immunity[d]	4/53 (7.5)	147/196 (75.0)	0.03 (0.01, 0.08)[g]	0.02 (0.005, 0.06)[g]
Afebrile ARD on arrival	70/124 (56.5)	81/125 (64.8)	0.70 (0.41, 1.21)	0.97 (0.47, 12.0)
Febrile ARD on arrival	13/21 (61.9)	138/228 (60.5)	1.06 (0.39, 2.93)	1.61 (0.42, 6.10)

NOTE. ARD, acute respiratory disease; OR, crude odds ratio; AOR, adjusted odds ratio; 95% CI, 95 percent confidence interval.

[a]Black, Hispanic, Asian, Pacific Islander, Other
[b]All countries in Central/South America, Africa, Pacific, Phillippines; Florida and Hawaii
[c]Region recruit spent majority of life to-date
[d]High initial titer ($\geq$1:32)
[e]$P < 0.05$
[f] $P < 0.01$
[g]$P < 0.001$

Table 13. Risk factors for ARD hospitalization in univariate and multivariate analysis

Risk factors	Number/total (%)		OR (95% CI), Univariate analysis	AOR (95% CI), Multivariate analysis
	When risk factor present	When risk factor absent		
Age (<20 years old)	62/172 (36.0)	21/77 (27.3)	1.50 (0.80, 2.83)	2.02 (0.76, 5.38)
Male gender	54/162 (33.3)	29/87 (33.3)	1.00 (0.56, 1.80)	1.04 (0.56, 1.91)
Training unit (A Company)	18/54 (33.3)	65/195 (33.3)	1.00 (0.50, 1.98)	0.86 (0.40, 1.83)
Non-white race[a]	41/130 (31.5)	42/119 (35.3)	0.84 (0.48, 1.48)	1.10 (0.50, 2.44)
Prior smoking history	40/108 (37.0)	43/140 (30.7)	1.33 (0.75, 2.34)	1.36 (0.75, 2.47)
Smoking member at home	35/115 (30.4)	48/133 (36.1)	0.77 (0.44, 1.36)	0.69 (0.39, 1.24)
Tropical region of birth[b]	14/41 (34.1)	69/206 (33.5)	1.03 (0.48, 2.20)	0.92 (0.29, 2.94)
Tropical growing-up region[c]	8/25 (32.0)	75/223 (33.6)	0.93 (0.35, 2.41)	1.05 (0.26, 4.33)
High initial immunity[d]	10/53 (18.9)	73/196 (37.2)	0.39 (0.17, 0.87)[e]	0.40 (0.18, 0.88)[e]
Afebrile ARD on arrival	45/124 (36.3)	38/125 (30.4)	1.30 (0.74, 2.29)	1.07 (0.59, 1.96)
Febrile ARD on arrival	13/21 (61.9)	70/228 (30.7)	3.67 (1.34, 10.20)[f]	4.85 (1.66, 14.16)[f]

NOTE. ARD, acute respiratory disease; OR, crude odds ratio; AOR, adjusted odds ratio; 95% CI, 95 percent confidence interval.

[a]Black, Hispanic, Asian, Pacific Islander, Other
[b]All countries in Central/South America, Africa, Pacific, Phillippines; Florida and Hawaii
[c]Region recruit spent majority of life to-date
[d]High initial titer (≥1:32)
[e]$P < 0.01$
[f]$P < 0.005$

Table 14. Distribution of AdV-PCR results per ventilator from non-extracted air filters samples.

Vent	Company (location)	Week of Training				
		0	2	4	6	8
1	A (West,2nd floor)	nd	+	+	+	-
2	A (East, 2nd floor)	-	+	+	+	+
3	A (West, 3rd floor)	-	-	-	+	-
4	A (East, 3rd floor)	-	+[a]	-	-	-
5	C (West, Top filter)	-	+	+	+	-
	C (West, Bottom filter)	-	+	+	+	-
6	C (East, Top filter)	-	+	+	-	-
	C (East, Bottom filter)	-	-	+	+	-
7	D (West, Top filter)	-	-	+[a]	+	-
	D (West, Bottom filter)	+[a]	-	+[a]	+	-
8	D (East, Top filter)	+	-	-	-	-
	D (East, Bot filter)	-	-	+	-	-

[a] Negative result when tested after extraction.
nd: not done

Figure 10. Distribution of Adenovirus (AdV)-hospitalized cases and AdV PCR-positive air filters per week of training. Bars represent total number of AdV cases (left scale) and dots represent percentage of air filters AdV-positive by PCR (right scale).

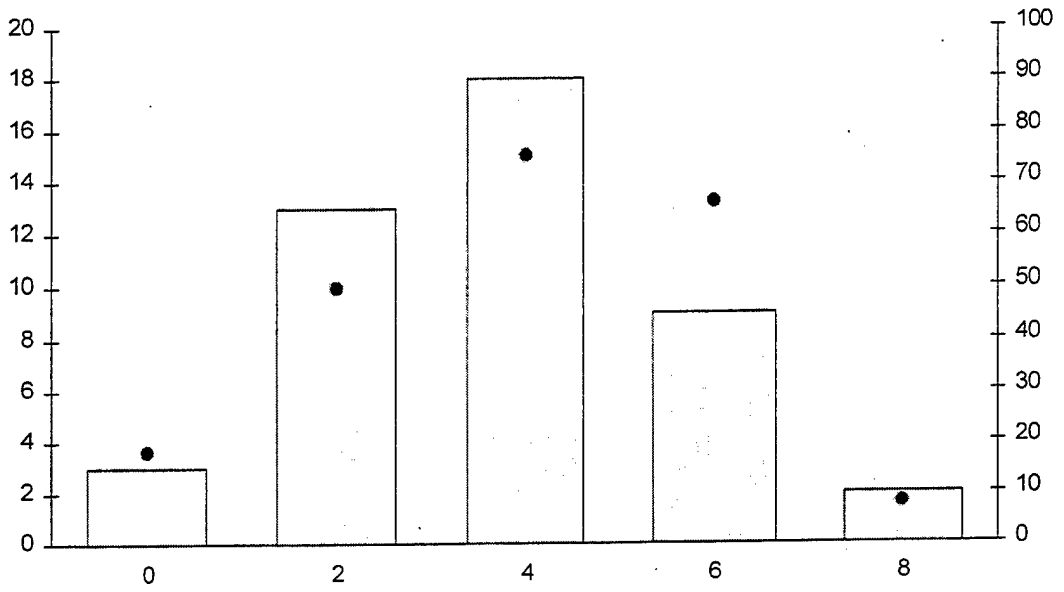


Table 15. Univariate Analysis for Selected Variables, Fort Jackson Cadre.

	ARD during cycle	No ARD	Odds Ratio (95% CI)	P Value
Sex				
Female	4	5	1.12 (0.20, 6.03)	1.0
Male	15	21	----	
Company				
A	4	10	----	
C	9	7	3.21 (0.56, 19.90)	0.25
D	6	9	1.67 (0.28, 10.46)	0.70
History of Smoking				
No	12	15	1.56 (0.37, 6.72)	0.71
Yes	7	11	----	
Job Description				
Drill Sergeant	12	15	1.26 (0.32, 5.05)	0.95
Other	7	11	----	
ADV vaccine				
No	10	11	1.56 (0.37, 6.72)	0.71
Yes	7	12		

Table 16. Distribution of anti-Ad4 immunity and respiratory illness among cadre personnel.

Serological Result	No. (%)	Company			Respiratory Illness		
		A	C	D	Febrile	Non-Febrile	Not Ill
Immune/partial immunity (titer $\geq$ 1:4)	34 (75.5)	9	3	12	6	6	22
Susceptible no seroconversion	8 (17.8)	4	1	3	0	4	4
Susceptible and seroconverters	3 (6.7)	1	2	0	1	2	0